

## Abstract

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# Muscle activation after ACL reconstruction: Influence of the resistance pad position

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**Objectives:** The question of anterior tibiofemoral joint shear force during active extension of the knee must be tackled with great attention when managing the rehabilitation of surgically reconstructed anterior cruciate ligament (ACL). The contraction of the quadriceps when the resistance pad of the isokinetic dynamometer lever arm is placed at the distal tibia tends to force the proximal end of the tibia anteriorly with respect to the distal femur [1]. This mechanism could damage the graft after a surgical repair. The magnitude of anterior shear force is significantly reduced when the resistance pad is moved closer to the proximal extremity of the tibia. Hence, practitioners frequently use either a proximal placement or an anti-shear device aimed at reducing the anterior shear, thus protecting the graft in the early phase of exercise. Nevertheless, as we demonstrated in a previous publication [2], the position of the resistance pad on the tibia influences the estimation of the strength deficit through a bilateral comparison. The aim of this study was to investigate the influence of the resistance pad positioning on the electromyographic (EMG) activity pattern of the flexor and quadriceps muscles after ACL reconstruction.

**Methods:** Twelve male subjects ( $28 \pm 7$  years old) with unilateral knee surgery were studied. All of them underwent an ACL reconstruction using a patellar tendon graft. The mean time between the surgery and the study examination was 24 weeks (range 22–26 weeks). Each patient benefited from a pain free bilateral isokinetic assessment for knee flexors and quadriceps in the con-

centric mode at  $60^\circ/\text{s}$  and  $240^\circ/\text{s}$ . Two different positions of the resistance pad either distal (dist) or proximal (prox) on the tibia were successively used for testing (order randomly assigned). At the same time, EMG activity was measured on the vastus medialis (VM), the rectus femoris (RF), the respective mass of internal hamstrings (IH) and external hamstrings (EH) using surface electrodes. EMG data were sampled at 1000 Hz and recorded using Noraxon Myosystem Software. Signals were rectified and smoothed (RMS 50). The average root mean square (RMS) represented muscle activity.

**Results:** The isokinetic strength deficits of the quadriceps (through a bilateral comparison) appeared significantly increased when the test was performed in a distal position of the resistance pad compared to a proximal position (at low velocity only). The quadriceps deficit at  $60^\circ/\text{s}$  averaged respectively  $36 \pm 14\%$  and  $19\% \pm 13\%$  in the distal and proximal positions ( $p < 0.05$ ). Strength deficit magnitude on flexors was not influenced by resistance pad position (respectively  $10 \pm 7\%$  and  $7 \pm 8\%$  in the distal and proximal positions at  $60^\circ/\text{s}$ ). The VM and RF activation pattern during isokinetic knee extension at maximal intensity was also modified by the resistance pad position on the tibia. At low velocity ( $60^\circ/\text{s}$ ), the prox/dist EMG activity ratio of both quadriceps muscle heads (Fig. 1) was significantly increased on the operated leg compared to the contralateral healthy side. By contrast, the prox/dist

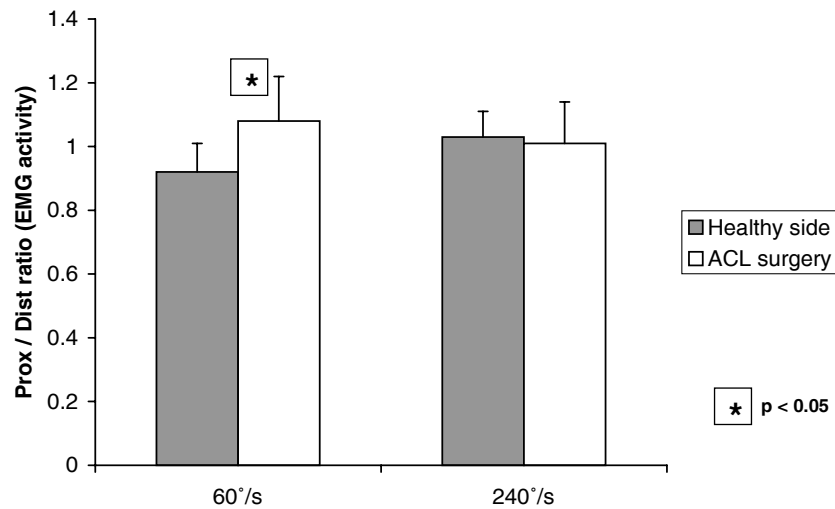


Fig. 1. Prox/Dist EMG activity ratio of the VM: comparative study between ACL reconstructed knee and the contralateral healthy joint.

EMG activity ratio of the IH and EH during flexion did not show significant difference between the two legs.

**Conclusion:** We concluded that, after an ACL reconstruction, the position of the resistance pad on the tibia during maximal isokinetic knee extension at a low angular velocity significantly influences quadriceps torque production and activation. Based on these observations, isokinetic users must reflect on the following points when they have to define the resistance pad position: (1) the safety of the graft referring to the ante-

rior shear forces; (2) the true estimation of the quadriceps deficit; (3) the optimal modalities in strengthening, taking into account inhibition phenomena.

## References

- [1] R. Nisell et al., *Am J Sports Med* **17** (1989), 49–54.
- [2] J.L. Croisier et al., *Actualités en Rééducation Fonctionnelle et Réadaptation*, Masson, Paris, 1995, pp. 239–245.